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STANDARDIZATION OF THE BALLISTIC MORTAR

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STANDARDIZATION OF THE BALLISTIC MORTAR

by

E.T. Pike*

SUMMARY

The ballistic mortar test, a measurement of an explosive's power, relative to TNT (dry 100 mesh), previously used tin foil to contain the explosive charge. A thinner aluminum foil has replaced the tin foil, thereby; extending the range of accurate comparison to TNT, reducing the standard deviation, and retaining the ability to compare any explosive to a previous sample (no matter which foil was used).

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STANDARDISATION DU MORTIER BLASTIQUE

par

E.T. Pike*

SOMMAIRE

La puissance relative d'un explosif par rapport au TNT (de maille 100 et séché) est mesuré au moyen du mortier ballistique. Lors d'essais antérieurs, on se servait d'une feuille d'étain dans laquelle était placée la charge explosive. On remplaça la feuille d'étain par une feuille d'aluminium plus mince, ce qui eut pour effet de prolonger d'un manière plus précise la comparaison avec le TNT, de réduire l'écart normal et de maintenir l'habileté à comparer tout explosif avec un échantillon antérieur, peu importe la sorte de feuille employée.

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INTRODUCTION

The ballistic mortar test is used to determine the relative strength of explosive substances.

The explosive propels a projectile from a mortar and the resulting vertical displacement due to the recoil is a measure of the explosive's strength relative to a standard, in this case, TNT.

Prior to 1974, the Canadian Explosives Research Laboratory (CERL) ran the ballistic mortar with 0.08 mm thick tin foil, weighing 1.73 g, and #6 fulminate/chlorate (F/C) detonators. In 1974, it was decided that due to the decreasing availability of F/C detonators CERL would use equivalent #8 plain detonators. In 1978, CERL converted the ballistic mortar to electric firing to eliminate the safety hazards involved when using plain detonators and safety fuse.

In 1982, CERL's supply of tin foil was running out. Due to decreasing availability and increasing cost of the tin foil CERL had to find a suitable substitute. Various commercial aluminum foils were tested, and the results are reported in Tables 3, 4 and 5.

APPARATUS

The ballistic mortar arrangement is shown in Fig. 1 to 3.

SAMPLE PREPARATION

Each shot consisted of the appropriate quantity of reference TNT (dry), contained in a foil cup, made by rolling a 7.6 cm wide by 15.5 cm long sheet to form a tube, then closing one end.

Each shot in the ballistic mortar was fired according to normal laboratory procedure.

RESULTS

The results were recorded in centimetres of recoil and plotted on a graph versus charge weight of TNT.

Table 1 - Tin foil (1.73 g - 0.080 mm thick)
thick) with #8 plain detonator

TNT (g)	Recoil (cm)
6.0	67.9
7.0	73.7
8.0	78.7
9.0	83.8
10.0	88.9
11.0	93.3
12.0	98.4
13.0	102.9

Table 2 - Tin foil (1.73 g - 0.080 mm thick)
with high strength detonator

TNT (g)	Recoil (cm)	Standard deviation
2.5	52.7	0.6
5.0	67.9	0.3
7.5	81.0	0.3
10.0	93.3	0.3
12.5	102.9	0.6
15.0	113.0	0.8

Table 3 - Aluminum foil (1.00 g - 0.120 mm thick)
with high strength detonator

TNT (g)	Recoil (cm)	Standard deviation
2.5	51.8	4.1
5.0	72.4	2.5
7.5	85.4	0.6
10.0	98.4	0.6
12.5	108.9	0.6
15.0	117.5	0.0

Table 4 - Aluminum foil (0.59 g - 0.080 mm thick) with high strength detonator

TNT (g)	Recoil (cm)	Standard deviation
4.0	63.0	1.4
5.0	70.9	1.1
6.0	75.9	0.8
7.0	80.3	0.4
8.0	84.9	0.3
9.0	92.9	1.3
10.0	96.2	1.1
11.0	103.5	1.0
12.0	106.3	0.5

Table 5 - Aluminum foil (0.44 g - 0.045 mm thick) with high strength detonator

TNT (g)	Recoil (cm)	Standard deviation
4.0	62.2	1.3
5.0	69.9	0.3
6.0	75.6	0.3
7.0	79.8	0.3
8.0	85.1	0.1
9.0	88.9	0.0
10.0	92.7	0.1
11.0	97.3	0.3
12.0	101.1	0.6
13.0	104.4	0.3
15.0	114.0	0.3

DISCUSSION

The change, in 1974, from plain detonators to high strength detonators added an average of 5.3% (range from 7.6 - 2.9%), thereby displacing the standardization curve to the right. The slope of the new curve changed also, due to the fact that as the weight of TNT per shot increased the effect of the added six grains of PETN (from the detonator) decreased.

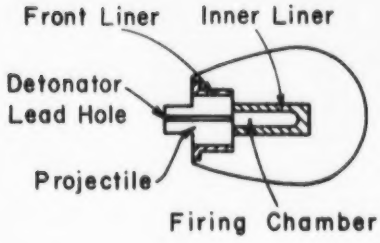
In 1982, the change to aluminum foil from tin foil displaced the standardization curve further to the right. The first aluminum foil tried was a commercial heavy duty foil which added 6.8% recoil to the standardization curve of tin foil and high strength detonators.

In order to reduce the influence of the aluminum foil it was decided to reduce the amount of aluminum, therefore a regular foil of 0.080 mm thickness, then a laboratory grade foil of 0.045 mm thickness were tested. The results are shown in Tables 4 and 5 respectively.

The results of a standardization using the laboratory grade indicated only a 1.2% average (1.0 - 1.4% range) increase over the tin foil (with high strength detonators).

Further testing and comparison of aluminum foil results to the previous tin foil results will continue as run of work samples become available.

The Table 5 results also show an increased range of accurate comparison of explosive samples to TNT, increased reproducibility and a reduced average standard deviation (from 0.13 to 0.10).



Section A-A

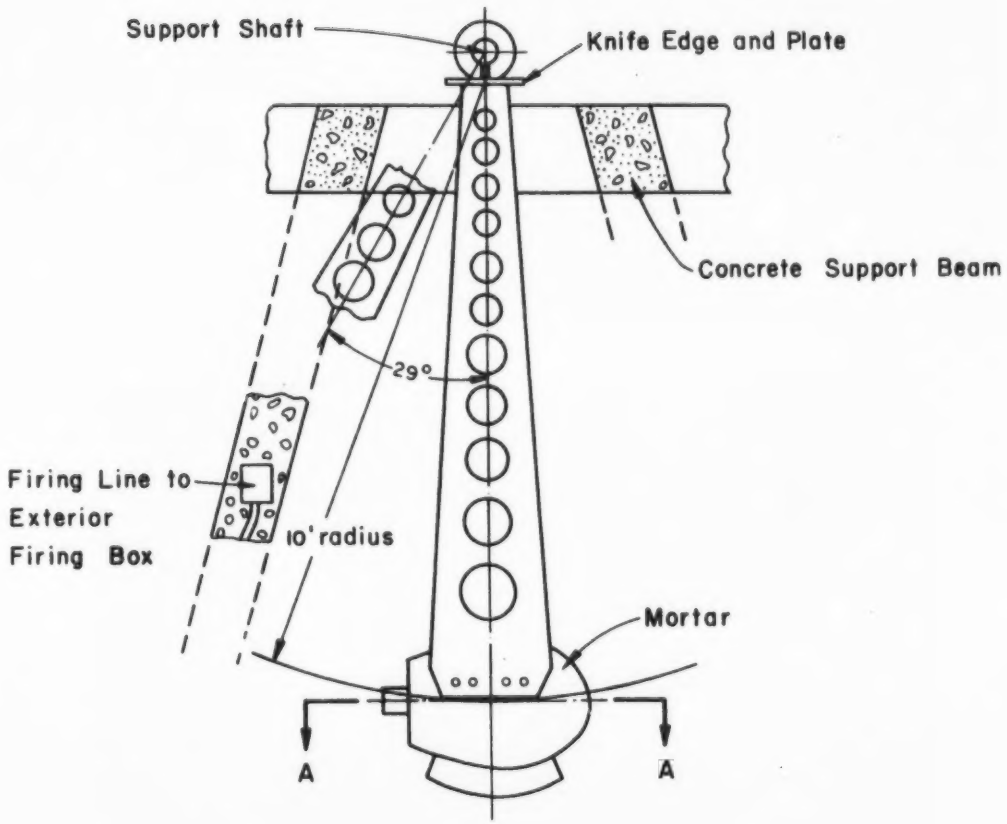


Fig. 1 - Ballistic mortar

Fig. 2 - Side view showing mortar recoil measurement scale

Fig. 3 - Front view

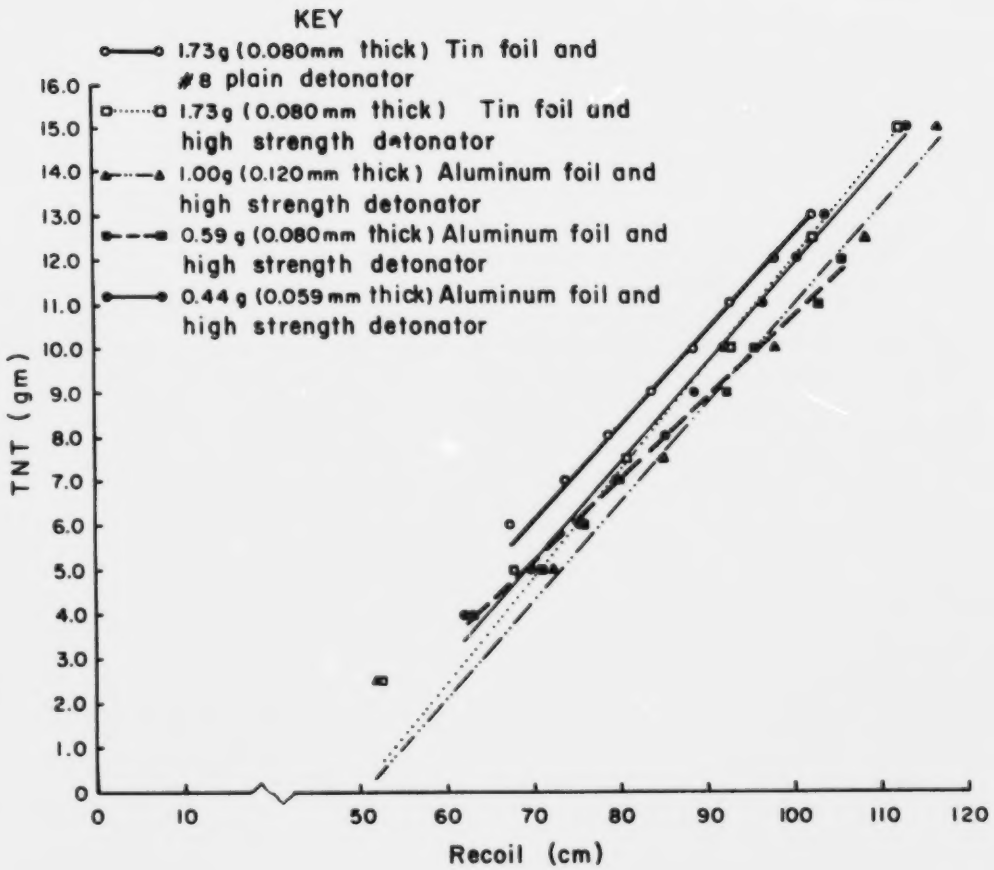


Fig. 4 - Grams of TNT versus recoil in cm

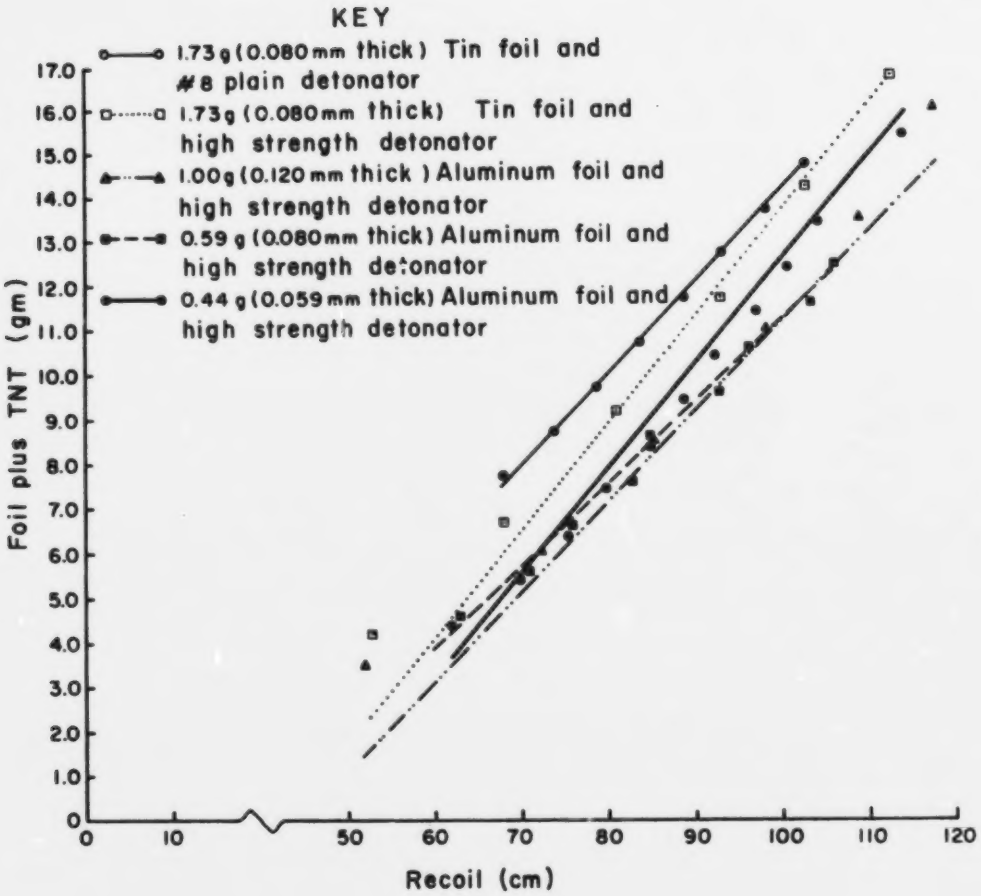


Fig. 5 - [gm TNT plus gm foil] versus recoil in cm

APPENDIX A

	% TNT
NG Sensitized Explosive	110-120
Amine Nitrate Sensitized Slurry	95-110
Organic Sensitized Slurry	90-115
Aluminum Sensitized Slurry	85-120
Black Powder FFFG	47
Black Powder Sulphurless Meal	27
Pyrotechnics	20-120